

Energy Management Package for Small Commercial Buildings

Erin Hult, Paul Mathew, Jessica Granderson Lawrence Berkeley National Laboratory January 15, 2014



Energy Management for Small Commercial Buildings Environmental Energy Technologies Division



❖ Goal:

- Develop packaged, highly 'commoditized' Energy Management solutions
 - Not the same as building management / Automation systems
- Low transaction costs
- Elements: Benchmarking, analysis of energy use data, walkthrough

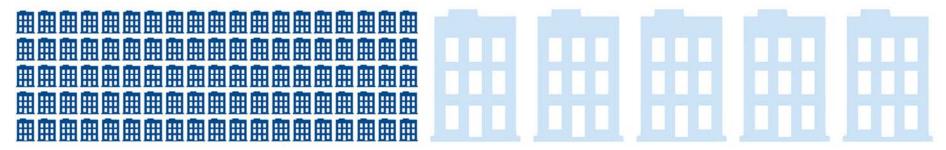




- 1 Why Target Small Buildings with Energy Management?
- 2 Scoping Study Findings
- 3 Technical Elements of Package
- 4 How Can Package be Integrated into a Business?
- 5 Pilot Demonstration Project
- 6 Feedback Channels
- 7 Next Steps

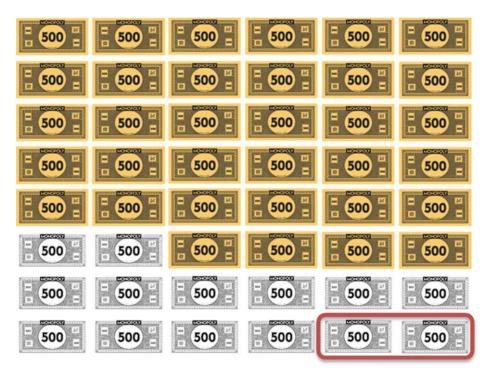


Buildings less than 50,000 sf consume **44%** of total commercial building energy.



95% of commercial buildings are less than 50,000 sf.





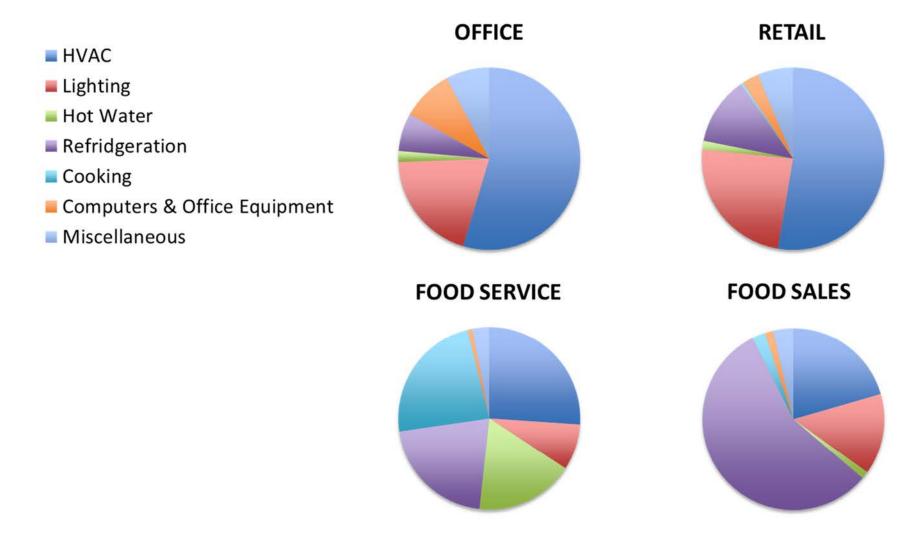
On average, **\$23,000** is spent on utilities every year in a small commercial building.

Cost-effective energy upgrades could reduce that by **30**%.

We're targeting 3-5% savings

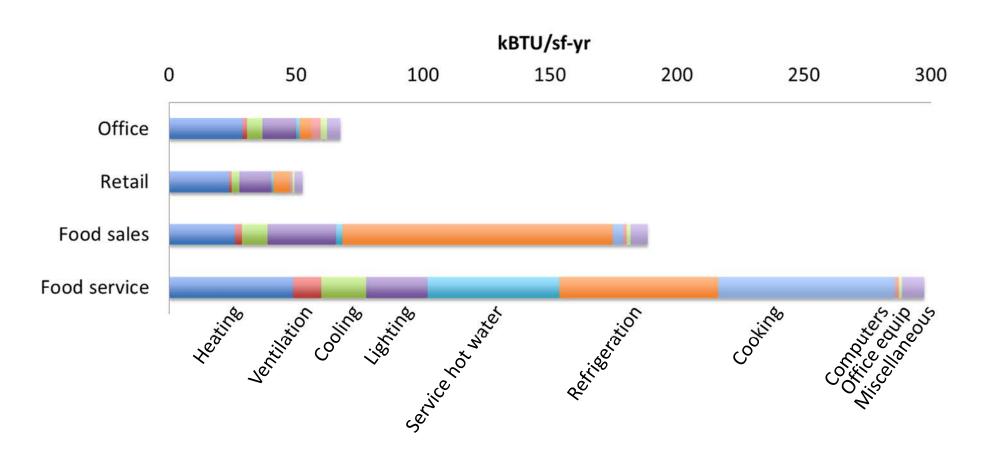


What is the biggest use of energy in small commercial buildings?





How do small commercial buildings use energy?





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4 Contractors, 2 Contractor associations

- Mix of client bases: small businesses, larger portfolios, schools
- ACCA directors in Michigan, Florida

6 Utility programs

- •PPL-Pennsylvania: Brian Stafford, runs contractor-based direct install program
- •PECI: Emily Pearce, program manager for AirCarePlus for PG&E
- Energy Trust of Oregon: Spencer Moersfelder, Business Sector Manager
- •Reliant: Paul Keene, VP of Middle Markets (SMB)
- TouchStone Energy: Tim Sullivan, Senior Director of Business Development
- •BC Hydro: Graham Henderson, Senior Program Manager, Commercial Marketing

6 EIS vendors

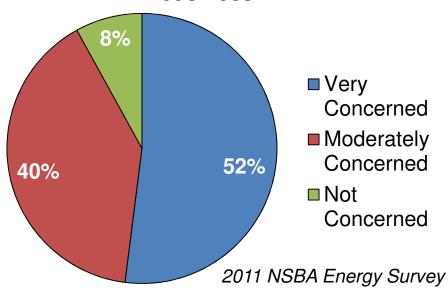
- •NorthWrite, Patrick O'Neill, Founder & CEO
- EnergyAi, Dave Krinkel, Founder
- Pulse, Bruce Herzer, Director of Marketing and Regulatory Affairs
- Lucid, Michael Murray, CEO
- •C3 Energy, Ed Abbo, President & CTO
- •WegoWise, Dan Teague and Craig Isakow

Scoping Study Findings



- Substantial energy use in Retail, Office, Food Sales, Food Service
- Underserved for Energy Management: low-cost opportunities exist
- Owner awareness varies
- Tools for larger buildings typically expensive & complex
- Occasional programs & tools, but not a single, straightforward tool that combines relevant pieces

How concerned are you about the future energy costs of your business?





Simple and inexpensive:

"...even if you have to give up on a level of accuracy, the most important thing is for tools to be simple and easy." - Utility program interviewee

"[Most contractors]...won't take the time to have their employees get the training [on tools]." - Contractor association interviewee

"Even if you have great ways of slicing and dicing, there isn't the time or expertise at the facility level to use that information (often even at large organizations)" - EIS vendor

Direct, actionable information:

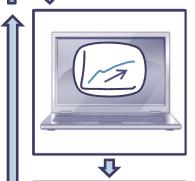
"How much did I save?", "Is my building on target?"

Two interviewees said that a simple one-page report for the owner is likely to be more effective than dynamic on-line tools.

"With more interval data available, there is a slowly growing opportunity for a very simple, very cheap tool that can pick out dominant patterns... and deviations from those patterns and present that information in a simple format." - EIS vendor



Based on the scoping study, we take the following approach:



Assess performance relative to peers (benchmarking);
 Check out trends and scheduling (2-3 hours)



❖ Walk through site to identify opportunities (1 hour)



- Verify changes and savings with building owner (1-2 hours)
- Continued monitoring of the facility is critical (every 6-12 mo)



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Technical Elements



Activity	Package elements
Analyze utility data & Benchmark relative to peers	Guidelines for how to analyze data and benchmark, Worksheet for analysis and tracking, List of some available tools
Analyze interval data (hourly, 15min)	Guidelines on how to obtain and analyze data, Worksheet for analysis and tracking, List of some available tools
Walkthrough	Checklist of things to look for, for example - programmed thermostat - occupancy sensors, location & presence Guidelines on how to problems
Communicating with owner	Guidelines on how to sell energy efficiency upgrades, Automated template to summarize status and recommendations, Resources to identify incentives, Tips on working with owner to set goals
Check results	Guidelines on how to evaluate results, Worksheet for analysis and tracking, Tips on how to proceed



The package makes use of already available, free or low-cost software to do the recommended analysis. The package contains a list of relevant tools.























Examples of tools are provided for informational purposes only. Those listed here and in the package are representative but not comprehensive.



To illustrate the package analysis, we use a site from the pilot demonstration:

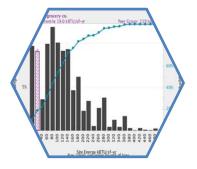
- Fast food restaurant
- ❖ 3000 sq ft
- ❖ Bay area location
- ❖ About \$26,000/yr energy costs



Element 1: Monthly Data & Benchmarking Environmental Energy Technologies Division

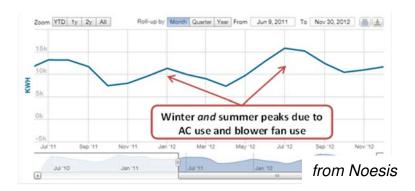


Analyze monthly data & benchmark

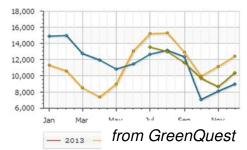


Requires:

- At least 1 year of monthly electricity and fuel use;
- Building floor area & type;
- 30-60 minutes
- A) What are the seasonal patterns?



B) How does this year compare with the previous year?



- C) How does my building compare to others?
 - ❖ Energy use intensity (kBTU / sf yr)
 - % of buildings with higher EUI (Energy Star Score)



from GreenQuest

Element 1: Monthly Data & Benchmarking Environmental Energy Technologies Division

E1 Benchmarking and Analysis of Monthly Energy Use

Plan to spend about 30-40 minutes on this element, including uploading the data

A list of tools that you could use for this analysis is provided at the end of these guidelines. The tools listed are generally intuitive to use and provide tool-specific instructions online.

Step 1 Gather & upload data

Gather ideally two years of monthly electricity and gas/oil use data (if two years is not available, use whatever is available). This can be downloaded from a utility website (see Obtaining Data in the Overview) or gathered from paper utility bills. Using an electronic file is highly recommended if possible, as manual data entry can be very time intensive.

🏅 Record additional building characteristics such as building type, floor area and year built on the

Step 2 Patterns in monthly energy use

Use a monthly energy analysis tool to plot the last year's energy use data. Look at total energy as well as fuel (gas, oil) and electricity.

- . If you typed in your energy data by hand in Step 1, look for any data entry errors indicated by significant deviations from the annual pattern and verify that data is entered correctly.
- . Look at the electricity and gas use pattern over the year: typically electricity use increases during periods of heavy air conditioner use in the summer, and gas or oil usage increases with heating use during the winter.
- · Food Service and food sales buildings may have high equipment loads that dominate seasonal conditioning trends.



Monthly electricity use plotted over time using Noesis.

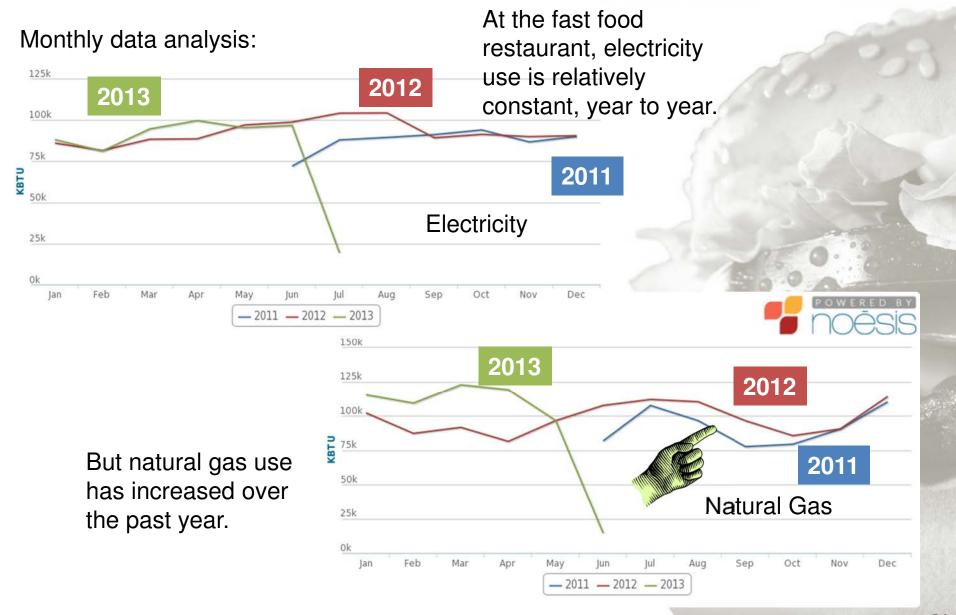
Note seasonal patterns in energy usage, displaying electricity and fuel use separately.

Building:		City:	_ Zip:_		Date:		2000000
Is energy use	er Data ectricity and gas bit or cost currently to Get paper utility bit	racked? yes no	how?			a de la	
	Download from util	ity website. Filena Use	me: rname:_				·
El-	lding type (circle): or area: I(s) used:	Veer builts					
on the summ	tools can automatic ary report and suppersions in monthly en	plement that inform				rksheet to h	ighlight key element
Total monthly energy usage	Peak season (ci	rcle): Summer				All months	s similar
Electricity usage	irregular/other: _	rcle): Summer rce? AC: yes / cted? yes / no				All months	s similar
Gas/Oil usage	irregular/other: _ Primary gas/liqu	rcle): Summer id fuel: natural rce? Heat: yes / es / no	gas oil	propa	ne other:		

E1 Benchmarking / Monthly Data Analysis G

Each element contains a set of guidelines (left) and a worksheet (right).





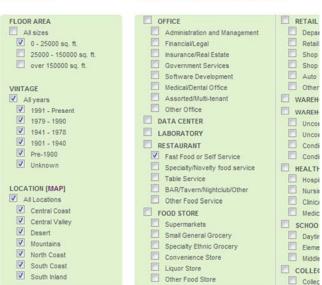


Benchmarking: Because Energy Star does not rate restaurants, EnergyIQ was used to benchmark the site against all fast food restaurants in California.

Define Peer Group

Select floor area, vintage, and location.

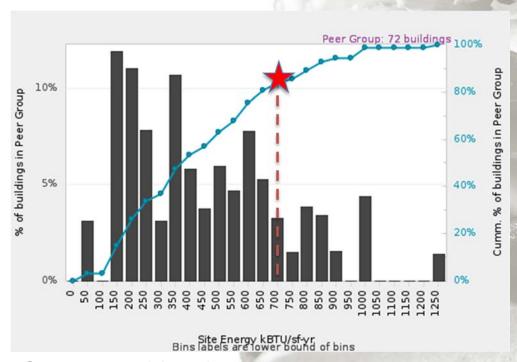
Then, select your building types.





energyiq.lbl.gov

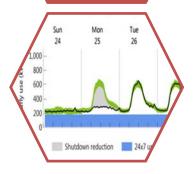
This fast food restaurant uses 729 kBTU/sf-yr



Only **15%** of fast food restaurants in California use more energy per square foot!

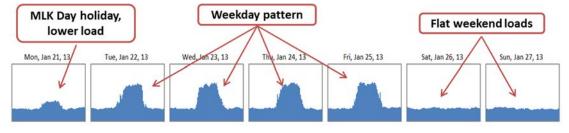


Analyze interval data

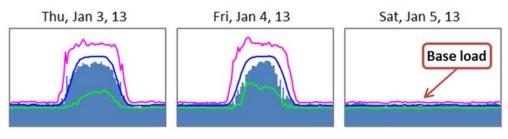


Requires:

- 3-12 months of hourly (smart meter) electricity data
- 30-60 minutes
- A) Are the daily and weekly load schedules as expected?



B) How much energy is used at night and on weekends (Base load)?



from BizEE

- C) Are there spikes or unusual activity?
- D) Can peak loads be reduced or shifted to non-peak periods in the day?
- E) Are there changes over time?

Element 2: Interval Data

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E2 Interval Data Analysis Guidelines

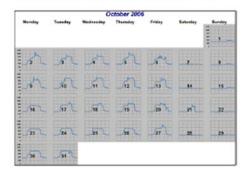
Plan to spend about 20-30 minutes reviewing a building's interval energy use data.

STEP 1 Upload data

Load interval data into the program. You need at least one month (as much as 6-13 months for some tools) of electricity use data reported every hour (or every 30, 20, 15 minutes). See 'Obtaining Interval Data'. At the end of this document, there is a list of tools that can be used for the analysis in this element.

STEP 2 Daily and weekly load schedule

Display electricity use data vs. time for a few weeks of interval energy use data.



Energy use for each day in the month of October 2006 using ECAM (from ECAM instruction manual). Note weekday vs. weekend schedule is typical, with abnormal activity on Saturday October 21.

Does the daily load profile have the same shape as you would expect? Specifically:



E2 Interval Data Analysis Guidelines -- DRAFT: Do Not Circulate

E2 Interval Data Analysis Work	Sheet Building:
STEP 1: Obtain & upload interval energy	use data
Either: Get file from owner. File nam	e:
	osite (recommended)Utility: Password:
Building floor area: Operat	ing hours:
Building type:(circle): office retail food:	service food sales other
Tool used to display interval data:	
STEP 2 Daily and Weekly Scheduling:	eks of daily loads
Weekly pattern (circle):	all days similar weekday/weekend weekday/Sat/Sun irregular/other:
Weekend load compared w/ typical: As owner expected?	same slightly lower much lower base load level yes / no
Holiday loads compared w/ typical: Which holidays (circle): As owner expected?	same slightly lower much lower base load level 1/1 MLK Pres. Mem. July4 Labor Colum. Vet. ThnksGiv 12/24 12/25 other: yes / no
Typical day scheduling: As owner expected?	Startup begins: Startup ends: Shutdown begins: Shutdown ends: yes / no
Notes on irregular activity: Include times where equipment may be running unnecessarily.	
STEP 3 Base Load: Base load level: Typical d	aily maximum lavel
Base load to daily maximum ratio:	2
Divide base load by typical daily max	
If ratio above is greater than 0.50, look	for opportunities to deepen setbacks.
E2 Interval Data A	nalvsis Worksheet DRAFT: Do Not Circulate



Options:

- Do analysis yourself
- Order automated analysis

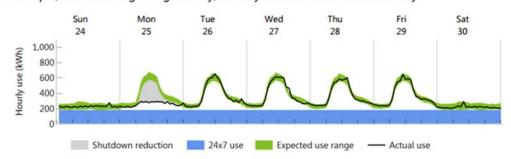
Sample report page from EnergyAl

Shutdowns

- **8 days** Number of "shutdown" days in the analysis period electricity use was much lower than expected, and was flat for most of the day.
- 16,700 kWh Reduced electricity use during the shutdown days. If use had been in the "expected range" for these days, this is how much additional electricity would have been used.
 - \$2,250 Estimated cost savings from the reduced electricity use.

A "shutdown day" occurs when equipment which can be turned off is shut down for most hours of the day. This is a day when the load is expected to rise and fall, but instead is flat and near the 24x7 demand. Shutdown days often occur around holidays.

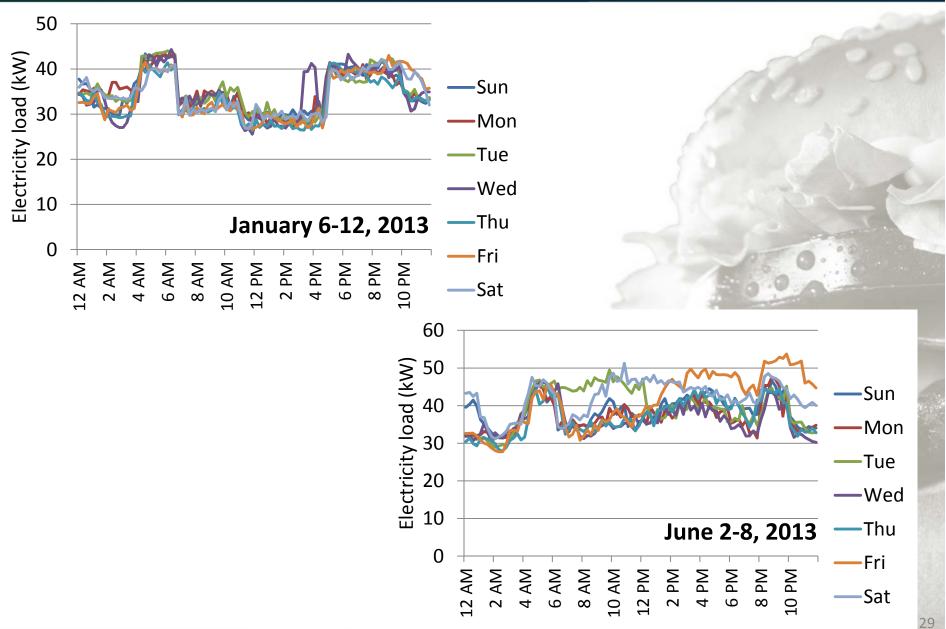
For example, the week beginning Sunday, 24 May 2009 has one shutdown day:



The 8 shutdown days occurred in 5 periods:

Holidays	
Labor Day	
Columbus Day	
Veterans Day	
anksgiving Day	





Element 3: Walkthrough

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1 hour walkthrough at building site

Check lighting & thermostat settings

Consult with manager about energy management practices

hon	3 Walkthrough Worksheet iilding: Date: cility contact name: one:			_;	Building operating hours: Weekdays to Saturday: to Sunday: to to Sunday:	
ist n	P 1 Overview najor energy consuming equipr ng:	ment in	this			5
V	If issues were highlighted in:				Pay special attention to question number:	
	E2 Step 3: High evening / weekend / base load				1, 5, 6, 7, 8, 11c, 11e, 12 (office), 13 (kitchen)	
	E2 Step 2: Load schedule doe occupancy schedule	E2 Step 2: Load schedule does not match occupancy schedule			8, 11a, 13 (kitchen)	
	E2 Step 5: High peak, daytime	E2 Step 5: High peak, daytime loads			11b, 11d, 9	
	E1 Step 5: High seasonal varia	ability			10	
\neg	P 2 Look for these items the Description	Yes	No	NA NA	Corrective Action / Comments	Solved ?
	Are occupancy sensors installed and working? Are they placed appropriately? Consult manager / occupant about functioning.					
	Are incandescents or T12 fixtures present?					
	Are fans or portable space heaters being used?					
	Are radiators and air vents clear and unobstructed?					
11111		2.30				

Element 3: Walkthrough



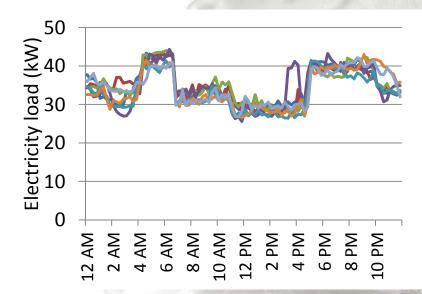
Specific walkthrough questions (bold are most important)

- Are occupancy sensors installed and working? Are they placed appropriately?
- 2. Are incandescent or T12 fixtures present?
- 3. Are fans or portable space heaters being used?
- 4. Are radiators and air vents unobstructed?
- 5. Are employees trained in energy conservation measures?
- 6. Are doors/windows kept closed during heating and cooling season?
- 7. Are computers and monitors set to sleep or off at night?
- 8. Are lights scheduled? (time-based on/off control)?
- 9. What is the most common HVAC complaint?
- 10. Are vending machines set to turn off/sleep at off hours?
- 11. Are thermostats programmed? (see 8a-8e) Are thermostats manually setback during off-hours?
 - 1. Does the setback schedule match occupancy schedule?
 - 2. Is heating setpoint for occupied hours 70 °F or lower?
 - 3. Is heating setpoint for off-hours 62°F or lower?
 - 4. Is AC setpoint for occupied hours 75°F or higher?
 - 5. Is AC setpoint for off-hours 78°F or higher?
- 12. Office: Are copy machines, printers & fax machines shut off at the end of the day?
- 13. Kitchen: Do you have a start-up/shutdown schedule for all equipment? Is equipment running or idling longer than necessary?
- 14. Kitchen: Is there a service maintenance schedule?
- 15. Kitchen: Are dishwashers only run when full?



Walkthrough findings at the fast food restaurant:

- Reduce parking lighting hours slightly
- ❖ Reduce dining room lighting hours / levels
- Adjust thermostat setback temp & timing



Other possible issues to check:

- Check gaskets on refrigeration units
- Consider more efficient cooking equipment options

Element 4: Communicate with Owner

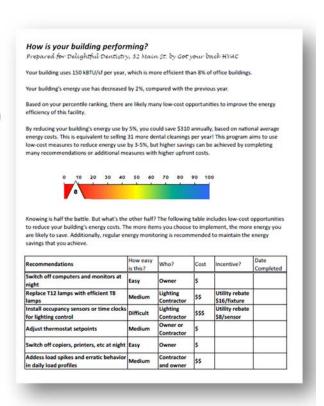
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Communicate with owner



- Tips on pitching efficiency measures
- Tool to generate summary (right)
- Incentive identification
- Goal setting guidelines
 - "I think together we can improve the Energy Star Score by 5 points this year."



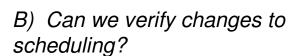






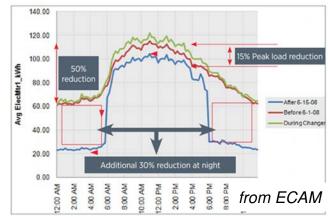
Requires:

- Updated monthly and/or hourly data
- 30-60 minutes
- A) How much energy as been saved?





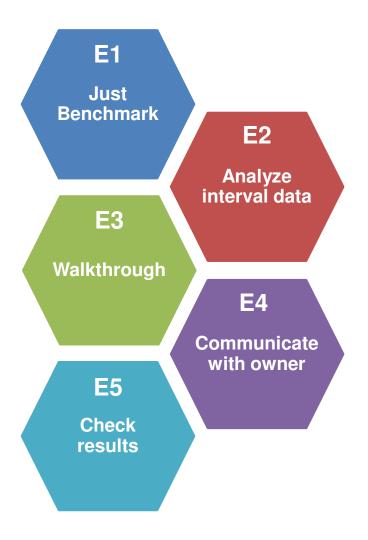
from Noesis



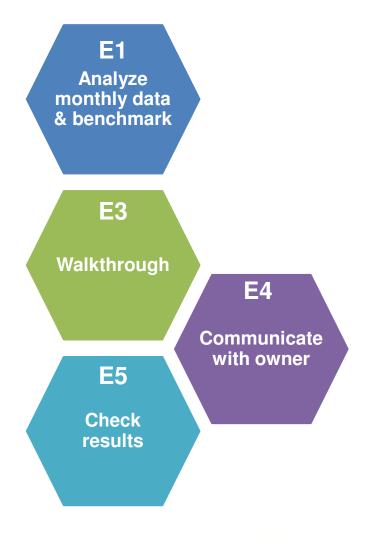
- C) Further steps to energy efficiency
- D) Leveraging success in future sales opportunities



With interval data available:



Just monthly data available:

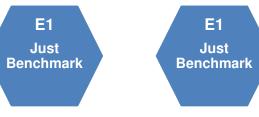




Screening a portfolio:



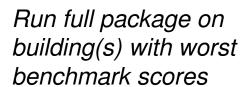
















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Why would a **contractor** participate?

- Differentiate your company
- Offer added value to customers through savings
- Identify additional service opportunities
- Gain credibility through third-party programs

Why would a **customer** participate?

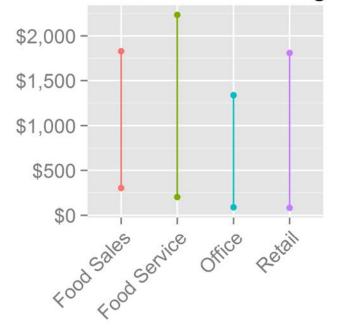
- Reduce costs
- Reduce hassle / maintenance
- Improve indoor environmental quality
- Reduce environmental impacts



What is the energy and cost savings potential?

- 5% savings (based on building commissioning results of Mills 2009)
- Median savings of \$200-900
- 10% with highest energy use: savings of \$1300-2300

Estimated Annual Savings



Based on total annual fuel expenditure for buildings <50k sf (CBECS, 2003)

Market Potential and Business Plan

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IS YOUR OFFICE FREEZING?

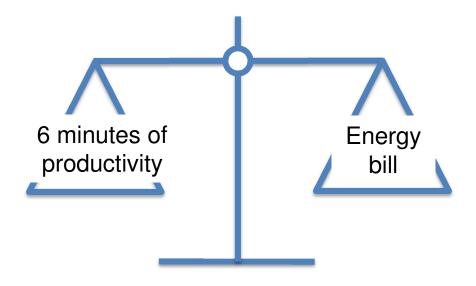
Your office services department might not be able to help, but our Italian featherweight cashmere certainly can.

SHOP THE STYLES >



Non-energy benefits, such as improved thermal comfort, can be significant.

Salary costs are 100 times energy costs in an office.



Based on average annual expenditures (Romm & Browning 1998)



How would the package be financed?

Option 1: Embed costs into maintenance contracts

"Rather than charging \$1500/yr, I would charge \$1700 or \$1750, and incorporate this into what I would offer them.... you're adding value in the maintenance spiel and can monitor usage"

contractor interviewee

Option 2: Offer a stand-alone service

"For an existing customer, I would do this the first year for free, and then the next year, I'd recommend they pay for this service given all the savings we were able to obtain."

contractor interviewee

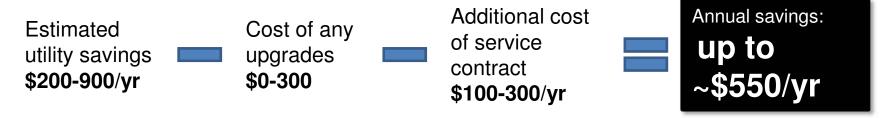


Option 1: Integrate into Service Contract

For the Contractor:



For the Customer:





Option 2: Stand-alone Offering

For the Contractor:



For the Customer:

As a separate offering, there is not expected to be net cost savings to the customer, except for the worst performing buildings which may have net savings of up to \$250/yr.



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Marina Mechanical in San Leandro



- ❖ Site 1: 27,000 sf Medical Office Building
 - Limited measures possible because it is made up of many tenanted spaces with their own lighting, tstat controls.
- ❖ Site 2: 3000 sf Fast Food Restaurant
 - ❖ Implemented Elements 1-4, working to implement measures

American Mechanical, Inc in Walnut Creek



Selecting a Demonstration Site



What are characteristics of the 'ideal' site?

- Must be less than 50,000 square feet
- Single building type (office, retail, food service or food sales), i.e., not mixed use.
- Must have: interval data for ~1 year back that we can access, that owner agrees to share.
- Must be individually metered, i.e., one building per gas or electric meter
- Must have: owner strongly motivated and highly likely to implement improvements
- Preferable: owner-occupied or single motivated tenant
- Preferable: not an already efficient building, so that decent levels of savings actually are possible.
- Preferable: differences between the two sites in terms of features such as programmable thermostats, occupancy sensors, etc.



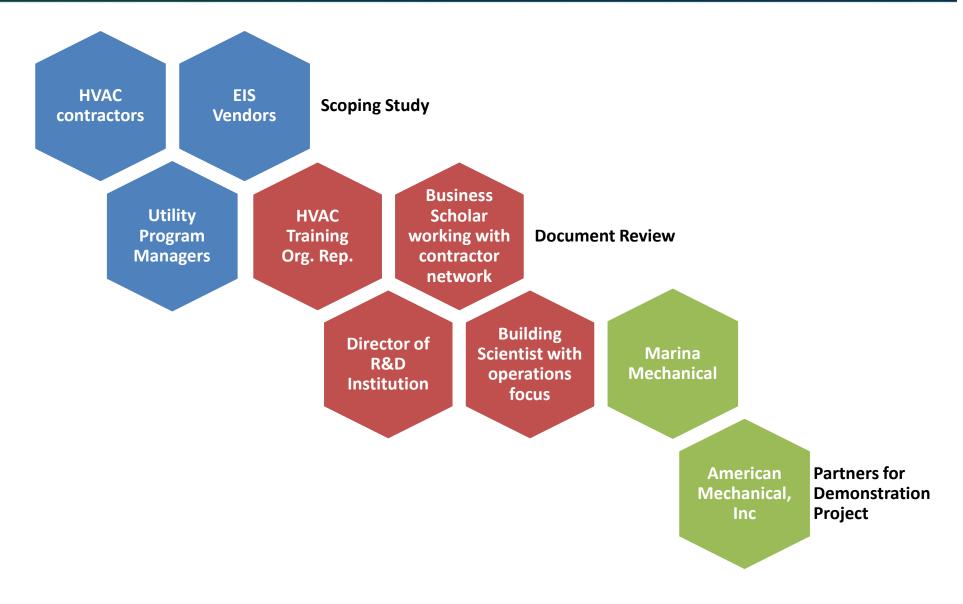
Lessons Learned

- Estimates of time taken and anticipated savings were validated
- Approach is better suited for owner-occupied buildings
 - Tenanted spaces have split incentives, more actors involved
- The level of technical skills of contractors varies
 - Minimize the number of tools required
 - Automated data access is critical
- Given the initiative and time required to learn new tools, incorporating package instruction into a formal training venue would be beneficial
- Interval data engages both contractors & building staff to understand energy use patterns



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Deployment Channels

Contractor training

Professional Organizations: SMACNA, ACCA

City disclosure requirements

Utility programs for small buildings

Building owner associations: BOMA

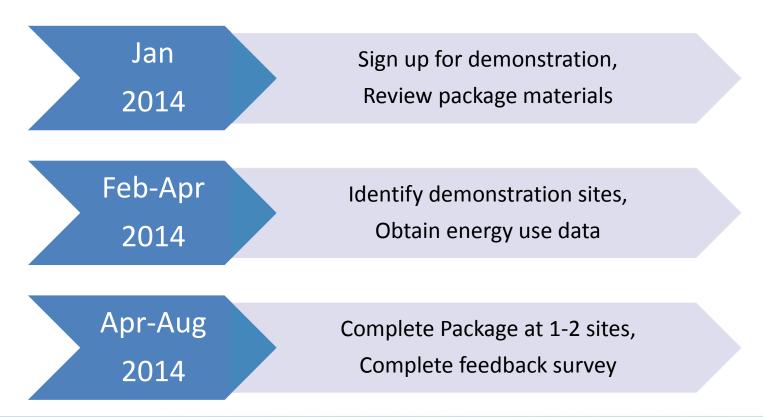
Environmental certification: Green Seal

Lawrence Berkeley National Laboratory, Department of Energy



Goals:

- 20-40 contractors complete the package in 1-2 buildings each
- Further validate business model, understand value to contractor
- Understand barriers to implementation
- Explore mechanisms for dissemination





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- Must be individually metered, i.e., one building per gas or electric meter
- Must have: at least 1 year of monthly utility billing data that owner agrees to share (smart meter data is even better).
- Preferable: owner strongly motivated and likely to implement improvements
- Preferable: owner-occupied or single motivated tenant
- Preferable: not an already very efficient building, so that decent levels of savings actually are possible.



What would this involve?

- Deploy package in 1-2 small commercial buildings
 - 2 -3 person-days
- Feedback on deployment experience
 - 2-3 Check-in phone calls of 15 min

What does LBNL provide?

- Package materials (PDF or MS Word form)
- Technical support by phone / web conference

Benefits to partners

- First chance to use a new offering & position company on leading edge
- Access to LBNL expertise
- Public relations opportunities
- Support publically-funded research



Please contact us if you are interested to participate in the 2014 Demonstration of the Energy Management Package.

If you are interested to participate:

Contact project staff

Read through package

Consider potential sites

Thank you for your time & attention!

Project website:

http://eis.lbl.gov/smallcomm.html

Erin Hult, 510-495-2036 ELHult@lbl.gov Jessica Granderson, 510-486-6792 JGranderson@lbl.gov